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Katahira

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[54] **DUST SUCTION APPARATUS**

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[51] **Int. Cl.**[6] **B08B 15/00**

[52] **U.S. Cl.** **454/64**

[58] **Field of Search** 454/49, 63, 64

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Primary Examiner—Harold Joyce
Attorney, Agent, or Firm—Sughrue, Mion, Zinn, Macpeak & Seas

[57] **ABSTRACT**

In a dust suction apparatus, a flexible sheet is provided on the open top of a channel body which communicates with an exhaust section. An opening support member is provided in a box-shaped slider, and separates a portion of the sheet from the open top of the body so that the sheet hermetically closes the open top except at the portion, and openings are made between the side edges of the portion of the sheet and the side portions of the body, and communicate with a dust generating part. The slider is disposed on the channel body so that the slider can be moved relative to the body along the longitudinal direction thereof as the slider remains in hermetic sliding contact with the body. The dust and the air are conducted from the dust generating part into the channel body through the openings between the portion of the sheet and the side portions of the body without elongating or compressing an exhaust tube as the part is moving.

26 Claims, 3 Drawing Sheets

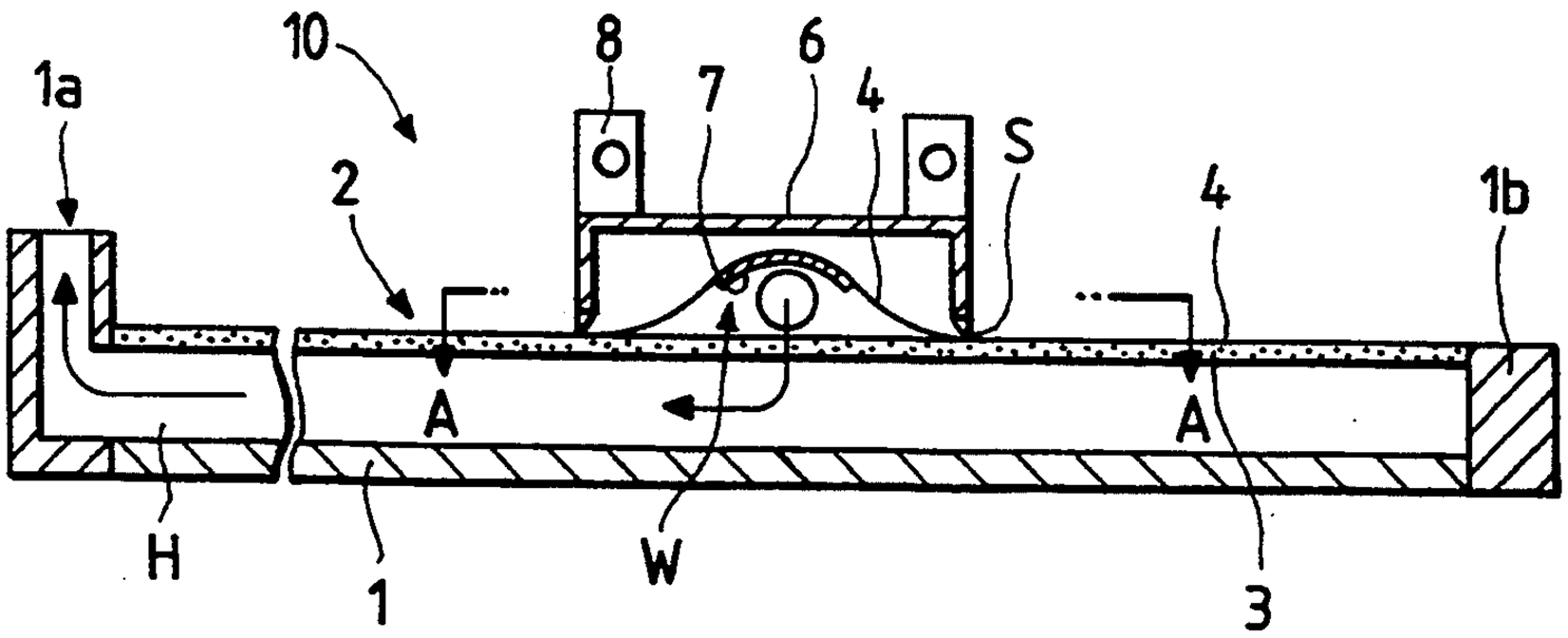


FIG. 1(a)

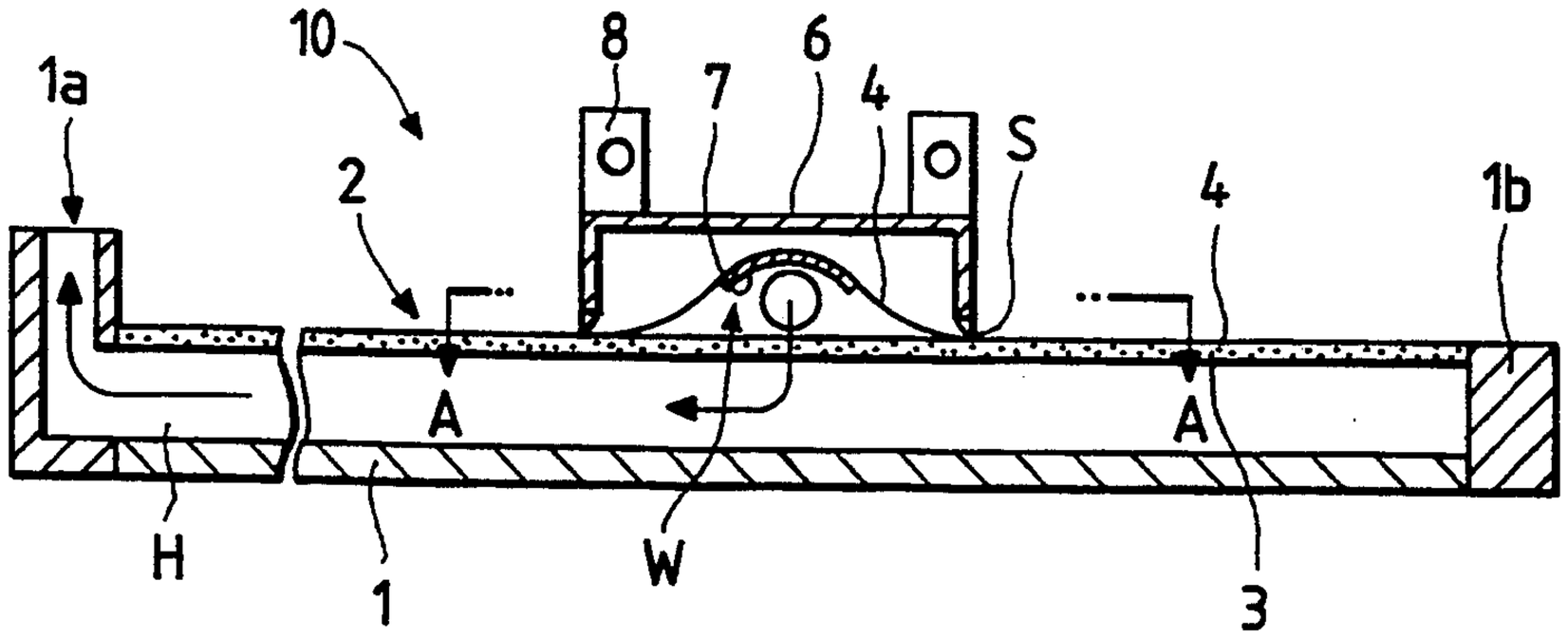


FIG. 1(b)

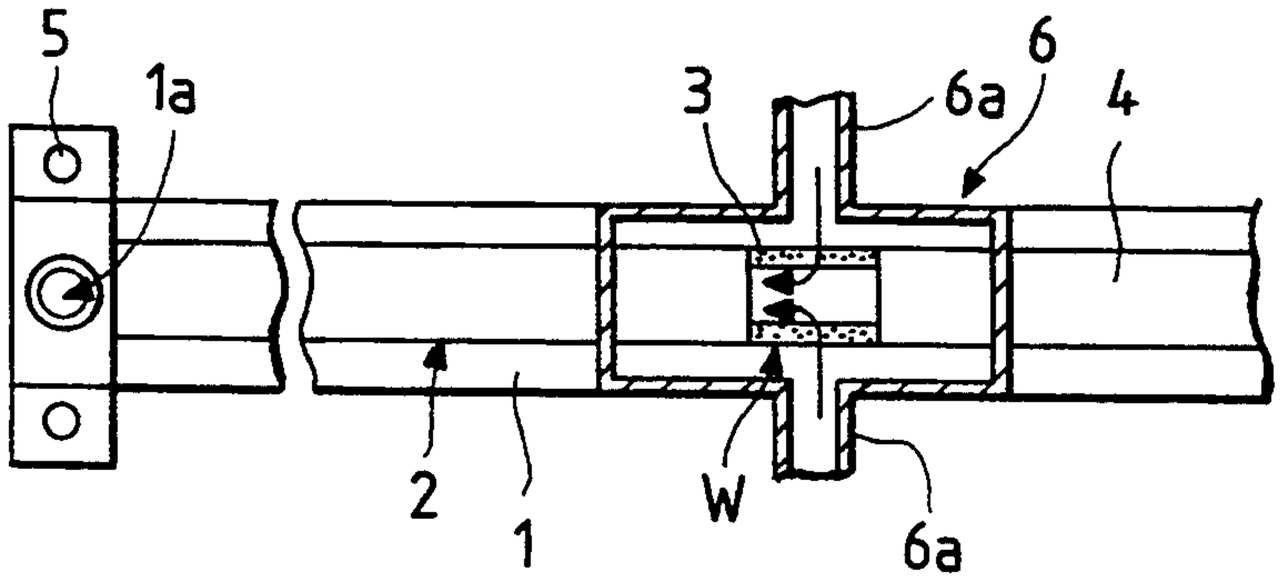


FIG. 1(c)

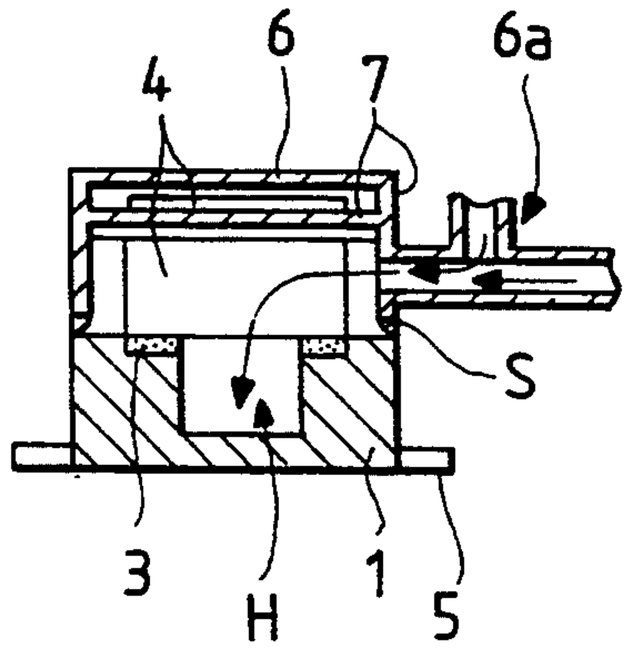


FIG. 2(a)

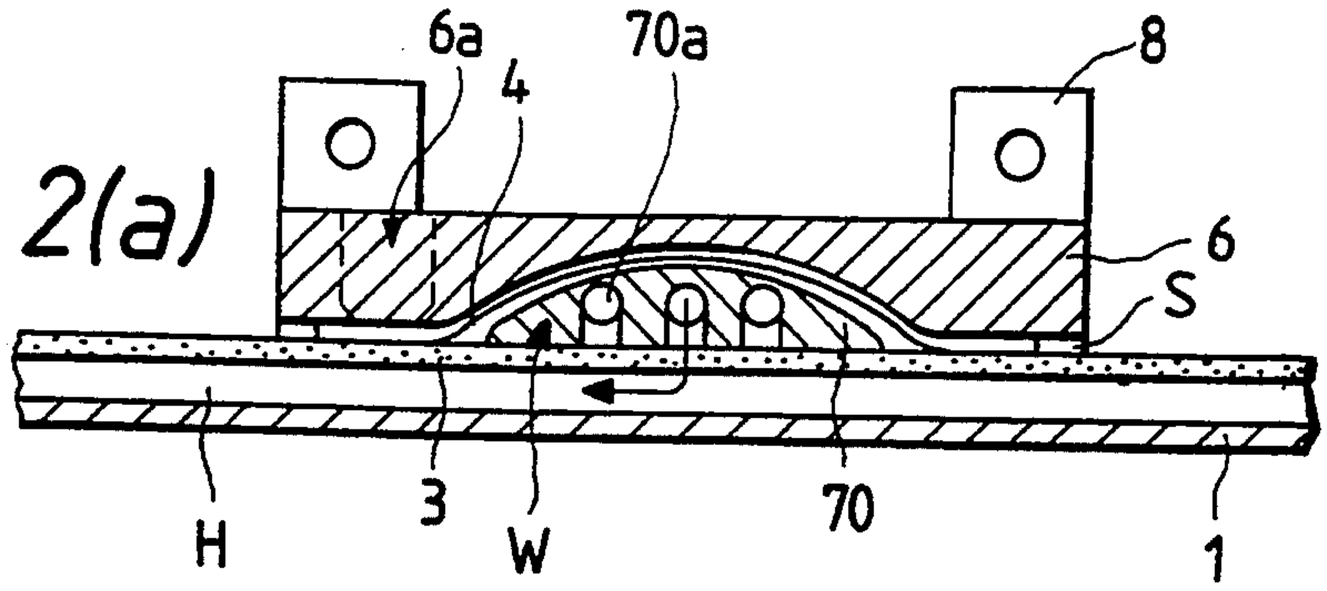


FIG. 2(b)

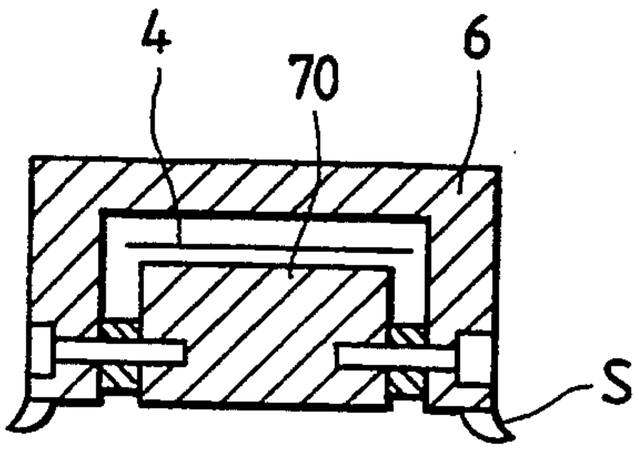


FIG. 2(c)

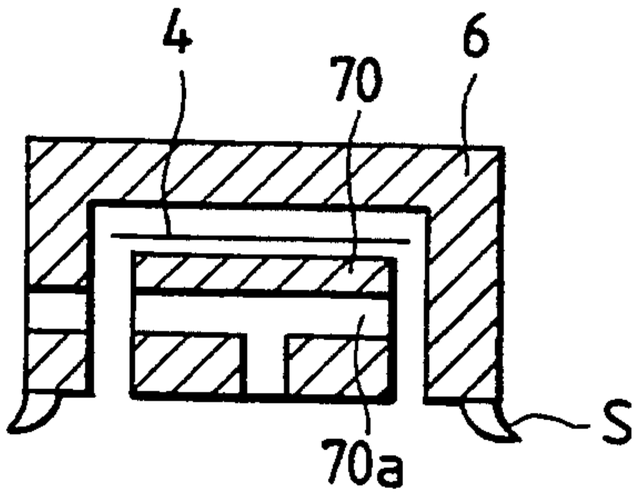


FIG. 3

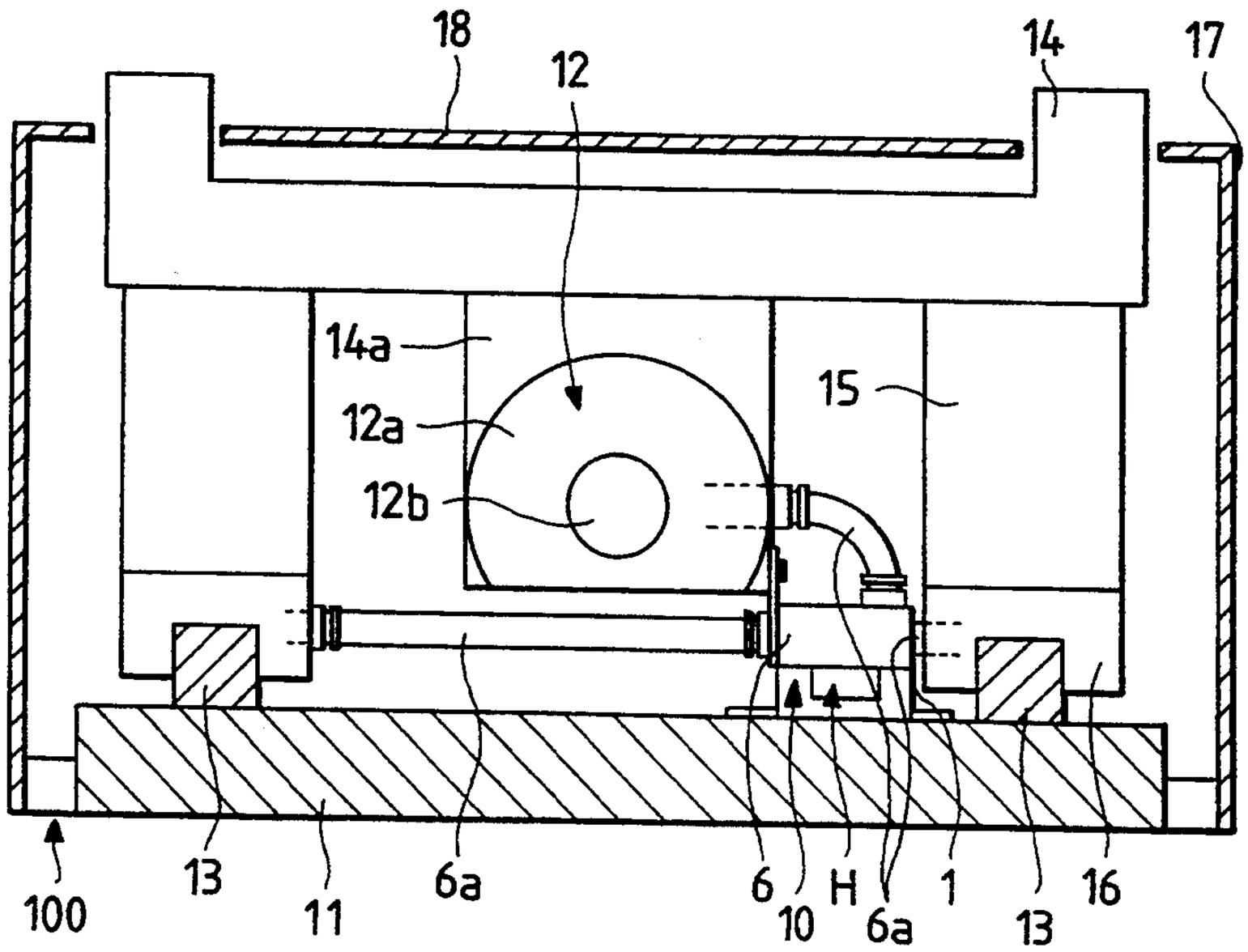
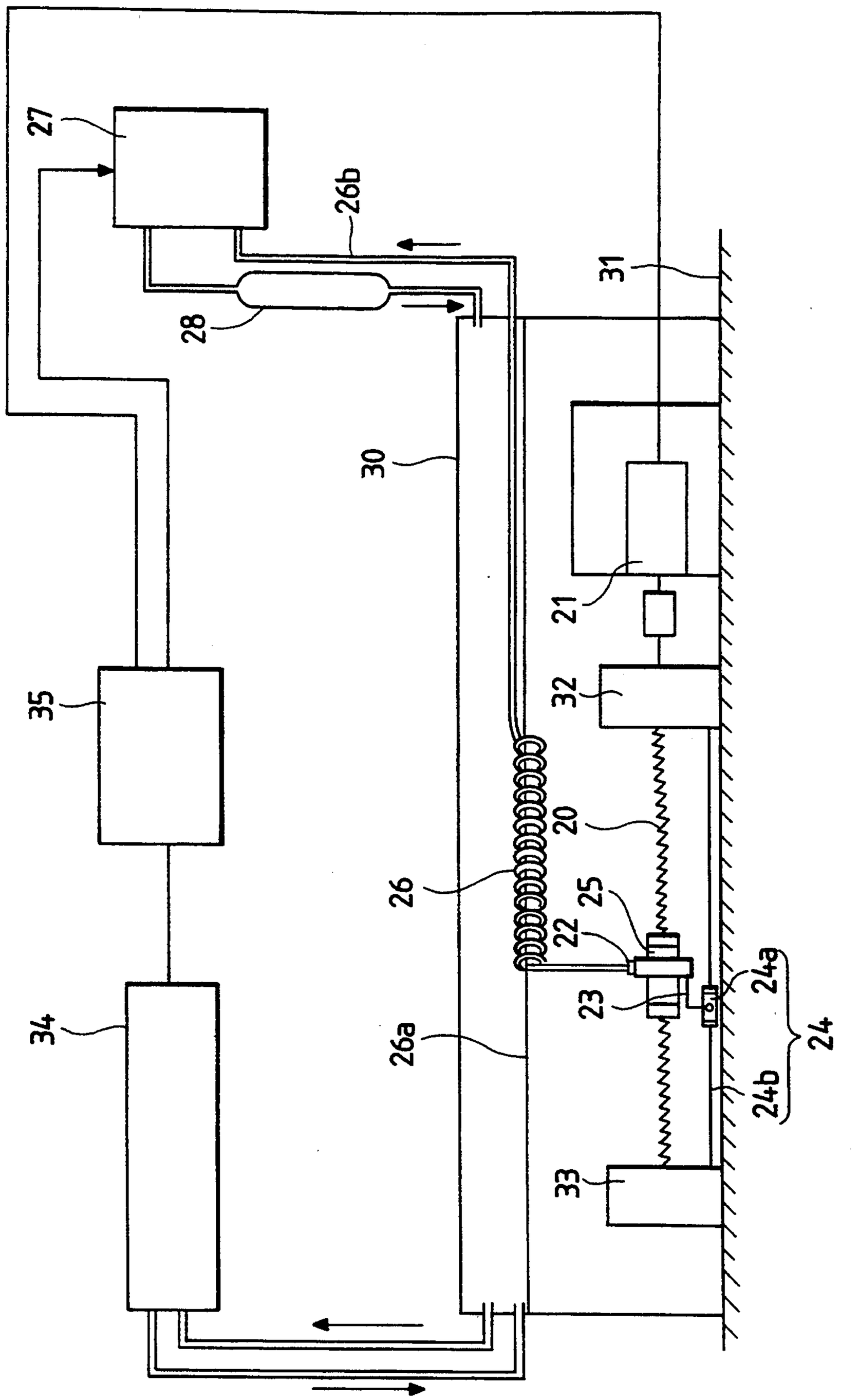


FIG. 4 PRIOR ART



DUST SUCTION APPARATUS

BACKGROUND OF THE INVENTION

The present invention relates to a dust suction apparatus, and more particularly relates to a dust suction apparatus for a semiconductor-manufacturing precision positioning table unit in a clean room.

A conventional dust suction apparatus for a positioning table unit in a clean room functions so that in order to remove powders produced by wear and minute particles of lubricant or the like (hereinafter referred to as dust) are produced from a moving part, such as a ball screw apparatus, a nut, a linear movement guiding mechanism and a support bearing, the dust and air located around the moving part are forcibly sucked together by a vacuum pump and sent to an air filter to catch the dust thereon and release the air to the atmosphere to keep no-dust environment therein as disclosed in the U.S. Pat. No. 4,955,244.

FIG. **4** shows the positioning table unit and the dust suction apparatus provided therefor. The unit includes a screw shaft **20**, a motor **21**, a support member **23**, a linear guide **24**, a nut **25**, a base **31**, and support blocks **32** and **33**. The screw shaft **20** is supported at both the ends thereof by the support blocks **32** and **33** secured to the base **31** in the clean room **30**, and is coupled to the motor **21** so that the shaft can be rotated by the motor. The linear guide **24** includes a bearing **24***a* and a rail **24***b*. The nut **25** is engaged with the screw shaft **20** and supported by the support member **23** and the linear guide **24** so that the nut can be straightly moved while being guided by the member and the guide. The nut **25** has a hole **22** extending from the outer surface of the nut to the inner surface thereof. The dust suction apparatus includes a spiral exhaust tube **26**, a support means **26***a*, a suction pipe **26***b*, an dust suction pump **27**, an air filter **28**, a dust counter **34**, and a control device **35**. The spiral exhaust tube **26** is connected to the hole **22** of the nut **25** by a nipple, and supported by the support means **26***a* so that the tube can be elongated and compressed along the support means. The suction pipe **26***a* connects the exhaust pipe **26** to the dust suction pump **27**. When the motor **21** of the table unit is put in action, the nut **25** is moved on the screw shaft **20** in a direction corresponding to that of the rotation of the motor. At that time, the dust generated at the nut **25** in the clean room **30** is sucked together with the air by the dust suction pump **27** through the exhaust tube **26** and the suction pipe **26***b* so that the dust is caught by the air filter **28**, and the air is then returned to the clean room **30**. An environmental servo system is composed of the dust counter **34** and the control device **35**. The concentration of the dust in the clean room **30** is always monitored by the dust counter **34**. Only when the concentration is lower that a prescribed level, the control device **35** acts to put the motor **21** in action.

Although the conventional dust suction apparatus which is of the vacuum suction type in which a dust generating part is subjected to vacuum suction to remove dust collects the dust effectively, the apparatus has problems that the exhaust tube **26** and the suction pipe **26***b* occupy spaces inside and outside the positioning table unit to restrict the travel of the table thereof, and the exhaust tube is moved along the movement of the table so as to make it likely to generate other dust.

SUMMARY OF THE INVENTION

The present invention was made in order to solve the above-mentioned problems. Accordingly, it is an object of the invention to provide a dust suction apparatus having a means for removing dust together with air without elongating or compressing an exhaust tube in a draging manner.

In the apparatus, a flexible sheet is disposed on the open top of a channel body which communicates with an exhaust section. An opening support member is provided in a box-shaped slider, and separates a portion of the sheet from the open top of the body so that the sheet hermetically closes the top except at the portion, and openings are made between the side edges of the portion and the side portions of the body, and communicate with a dust generating part. The slider is disposed on the channel body so that the slider can be moved relative to the body along the longitudinal direction thereof as the slider remains in hermetic sliding contact with the body. As a result, the dust can be conducted together with the air from the dust generating part into the channel body through the openings without elongating or compressing the exhaust tube in a draging manner as the dust generating part is moving.

The dust suction apparatus provided in accordance with the present invention can be applied to an optional device having the dust generating part which usually moves in mechanical contact.

For example, the device is a positioning table unit. The channel body of the dust suction apparatus is disposed in parallel with the screw shaft of the ball screw means of the table unit, closed at one end of the body, and open at the other end thereof so that the body communicates with the exhaust section. The flexible sheet is made of a metal, and magnetically attracted on the open top of the body so that the sheet hermetically closes the top to form an exhaust passage in the body. The box-shaped slider is disposed on the open top of the body so that the slider can be moved relative to the body along the longitudinal direction thereof as the sliding skirt of the slider remains in hermetic sliding contact with the body to keep external air from entering into the slider. The opening support member is provided in the slider to lift the portion of the sheet from the open top of the body to make the openings between the side edges of the portion of the sheet and the side portions of the body so that the dust and the air can be conducted into the exhaust passage in the body through the openings. A communication passage is connected to the slider so that the dust generating part of the table unit communicates with the exhaust passage in the channel body through the communication passage and the openings. The dust and the air are conducted from the dust generating part into the slider through the communication passage so that the dust and the air flow into the channel body through the openings, and then proceed to the exhaust section. When the ball screw means is put in action, the nut of the means is moved on the screw shaft thereof along the longitudinal direction of the shaft so that the slider is moved relative to the channel body along the longitudinal direction thereof, and the support member is also moved relative to the body along the longitudinal direction thereof while supporting the flexible sheet at the portion thereof up from the body to make the openings between the side edges of the sheet and the side portions of the body. At that time, the dust and the air are conducted from the dust generating part

into the slider through the communication passage so that the dust and the air flow out of the slider into the channel body through the openings, and then proceed from the body to the exhaust section. Even if dust is generated due to the sliding of the portion of the support member on the flexible sheet, the dust does not go out of the apparatus but flows from the slider into the channel body because the support member is located in the slider.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1**(*a*) is a longitudinally sectional view of a dust suction apparatus which is a first embodiment of the present invention;

FIG. **1**(*b*) is a plan view of the apparatus taken along line A—A in FIG. **1***a;*

FIG. **1**(*c*) is a cross-sectional view of the apparatus;

FIG. **2**(*a*) is a longitudinally sectional view of a dust suction apparatus which is a second embodiment of the invention;

FIG. **2**(*b*) is a cross-sectional view of the apparatus of the second embodiment to illustrate the secured portion of the opening support member thereof to the slider thereof;

FIG. **2**(*c*) is a cross-sectional view of the apparatus of the second embodiment to illustrate the communication holes of the support member;

FIG. **3** is a cross-sectional view of a positioning table unit provided with the dust suction apparatus; and

FIG. **4** is a schematic view of a positioning table unit provided with a conventional dust suction apparatus.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention are hereafter described with reference to the drawings attached hereto.

FIG. **1** shows a dust suction apparatus **10** which is a first embodiment. The apparatus **10** includes a channel body **1**, an exhaust means not shown in FIG. **1**, band-like magnets **3**, a flexible metal sheet **4**, a slider **6**, and an opening support member **7**.

The channel body **1** has a U-shaped cross section, an exhaust port **1***a* provided at one end of the body (at the left-hand end thereof as to FIG. **1**) and communicating with the exhaust means, and an end plate **1***b* closing the body at the other end thereof. The band-like magnets **3** extend on the inner surfaces of both the side portions of the body **1** at the open top **2** thereof so that the flexible metal sheet **4** can be magnetically attracted on the magnets to hermetically close the open top. The body **1** and the sheet **4** thus constitute a duct means having an exhaust passage H communicating with the exhaust means. A plastic sheet may be provided instead of the metal sheet **4** so as to be put in tight contact with the side portions of the body **1** by negative pressure therein to hermetically close the open top **2** of the body. The body **1** has flanges **5** secured to the base of a positioning table unit from which dust is to be removed by the apparatus **10**.

The slider **6** is shaped as a box, and open at the bottom thereof. A communication passage **6***a* extends from the side of the slider **6** so that the dust and air can be conducted from the moving part of the table unit to the internal opening **6** through the passage. The slider **6** has a skirt S in hermetic sliding contact with the tops of the side portions of the body **1** so that the slider can be moved relative to the body along the longitudinal direction thereof. The slider **6** has flanges **8** secured to the moving part of the table unit.

The opening support member **7** is provided in the slider **6**, and supports the metal sheet **4** at a portion thereof up from the magnets **3** so that openings W are made between the side edges of the portion of the sheet and the side portions of the body **1**, and one of the openings faces the end of the communication passage **6***a* in the slider **6**. The member **7** is a plate bent as an arc, and borne in the slider **6** to lift the metal sheet **4** at the portion thereof to make the openings W between the side edges of the portion and the side portions of the body **1**.

FIG. **2** shows a dust suction apparatus which is a second embodiment. The apparatus includes an opening support member **70** which has a crescent-shaped longitudinal section and communication holes **70***a* through which both the sides of the member communicate with the bottom thereof. The apparatus also includes a channel body **1**, band-like magnets **3**, a flexible metal sheet **4**, and a box-shaped slider **6**. The support member **70** is disposed in the slider **6**. A communication passage **6***a* extends from the dust generating part of a positioning table unit to the upper portion of the slider **6** so that dust and air are conducted from the part into the slider through the passage, flow into the communication holes **70***a* of the support member **70** through openings between the side edges of a portion of the metal sheet **4** and the side portions of the slider and through the sides of the support member, and finally enter into the exhaust passage H of the body **1** through the bottom of the support member. The distance between the side portions of the slider **6** is larger than the width of the metal sheet **4** so that the width of each of the openings between the side edges of the portion of the sheet and the side portions of the slider is large enough to enable the dust and the air to smoothly flow through the openings.

Reference numeral **8** disignates a flange member for mounting the slider **6** to a movable member from which a dust is sucked.

An example of use of each of the dust suction apparatuses for the positioning table unit **100** is described with reference to FIG. **3** from now on. The unit **100** includes a long base **11**, a ball screw means **12**, two linear guide rails **13**, a table **14**, spacers **15**, linear guide bearings **16**, and sound insulation covers **17** and **18**. The base **11** is secured to the floor of a clean room in which the suction apparatus and the table unit are installed. The ball screw means **12** is supported by the base **11**, and extends in parallel therewith. The guide rails **13** extend at both the sides of the screw **12***b* of the ball screw means **12** in parallel with the shaft. The table **14** is supported through a bracket **14***a* by the nut **12***a* of the ball screw unit **12**, the guide rails **13**, the spacers **15** and the bearings **16** so that the table can be straightly moved back and forth while being guided by the rails. The table **14** is connected to the motor of the table unit **100** through the nut **12***a* and screw shaft **12***b* of the ball screw means **12**. When the motor connected to the screw shaft **12***b* through a coupling is rotated, the nut **12***a* engaged with the shaft and the table **14** are straightly moved together back or forth.

The body **1** of the dust suction apparatus **10** extends in parallel with the screw shaft **12***b* and the linear guide rails **13**. The slider **6** is secured at the flanges **8** thereof to the sides of the nut **12***a* so that the dust and the air at the nut **12***a* are conducted therefrom into the slider **6** through the communication passage **6***a* and the top of

the slider and the dust and the air at the linear guide bearings **16** are conducted therefrom into the slider through the other communication passage **6***a* and the side of the slider as the apparatus is in action. The sound insulation cover **17** constitutes both sides and both ends of the table unit **100**, the other sound insulation cover **18** constitutes a part of the top of the unit, so that the covers prevent internal noises from going out of the unit.

When the motor of the positioning table unit **100** is put in action, the table **14** thereof, the nut **12***a* engaged with the screw shaft **12***b* and the slider **6** secured to the nut are moved together along the linear guide rails **13**. At that time, the slider **6** remains in hermetic sliding contact with the side portions of the channel body **1** of the dust suction apparatus **10** through the skirt S.

As for the dust suction apparatus including the opening support member **7** shown in FIG. **1**, the member lifts the flexible metal sheet **4** at the portion thereof to make the openings W and is moved along the exhaust passage H in the channel body **1** of the apparatus. The dust generated at the nut **12***a* and the two linear guide bearings **16** is conducted together with the air into the slider **6** through the communication passages **6***a* through the side of the slider **6** so that the dust and the air flow into the exhaust passage H in the body **1** through the openings W, and then proceed to the exhaust means of the apparatus through the exhaust port **1***a*.

As for the dust suction apparatus including the opening support member **70** shown in FIG. **2**, the dust generated at the nut **12***a* is conducted together with the air into the slider **6** through the communication passage **6***a* and the top of the slider, the dust generated at the linear guide bearings **16** is conducted together with the air into in the slider through the other communication passage **6***a* and the side of the slider, so that the dust and the air flow into the exhaust passage H in the channel body **1** of the apparatus through the openings between the side edges of the flexible metal sheet **4** and the side portions of the slider, the openings W between the sheet and the magnets **3**, and the communication holes **70***a*, and then proceed to the exhaust means of the apparatus through the exhaust port **1***a* thereof.

The exhaust system of each of the dust suction apparatuses is simpler and more compact than that of the conventional dust suction apparatus despite the constitution of each of the opening support members **7** and **70**, and does not interfere with an ambient member nor is elongated or compressed as the latter. Besides, the flow of the air in the exhaust system of each of the apparatuses which are the embodiments appropriately cools the system.

The present invention is not confined to the embodiments, but may be embodied or practiced in other various ways without departing from the spirit or essential character of the invention. For example, the invention may be embodied as a dust suction apparatus for a device which is not a positioning table unit and has a moving part at which dust is generated.

In a dust suction apparatus provided in accordance with the present invention, a flexible sheet is disposed on the open top of a channel body which communicates with an exhaust means, and an opening support member is disposed in a box-shaped slider, and separates a portion of the sheet from the body so that the sheet hermetically closes the open top thereof except at the portion, and openings are made between the side edges of the portion of the sheet and the side portions of the body. Since the slider is moved as the dust generating part of a device from which dust is to be removed by the apparatus communicates with exhaust means through the openings, the exhaust men%her of the apparatus is not elongated or compressed. Besides, the space occupied by the apparatus at the device is minimized. The dust is sucked together with air from the dust generating part into the channel body of the apparatus through the openings between the flexible sheet and the body so that the dust and the air are discharged from the body, and the dust is removed. Since the suction of the air acts to cool the apparatus and the device, the accuracy of their operation can be enhanced. The apparatus and the device can thus be made compact and high in accuracy and stability of operation in a clean room.

What is claimed is:

1. A dust suction apparatus for sucking dust generated at atleast one of a linear movement guiding member and a ball screw member of a linearly movable table positioning unit comprising:

a channel body communicating with an exhaust section and having an open top extending in a longitudinal direction of said channel body, said channel body being arranged in parallel with at least one of a linear guide rail of said linear movement guiding member and a screw shaft of said ball screw member;

a flexible sheet for hermetically closing said open top;

a sliding member movable on said body along the longitudinal direction of said body while said sliding member remains in hermetic sliding contact with said body; and

an opening forming means provided in said sliding member for continuously separating a portion of said sheet from said open top so that said sheet hermetically closes said open top except at said portion, and for forming openings which communicate with said at least one of said linear movement guiding member and said ball screw member through a communication passage.

2. A dust suction apparatus according to claim **1**, in which said flexible sheet is made of metal.

3. A dust suction apparatus according to claim **2** further comprising:

a band-shaped magnet member for magnetically contact with said metal flexible sheet, said band-shaped magnet member provided at both the side portions of said body at said open top thereof.

4. A dust suction apparatus according to claim **1**, in which said sliding member comprises a box-shaped slider which opens at the bottom thereof and a skirt in hermetic sliding contact with the side portions of said body.

5. A dust suction apparatus according to claim **3**, in which said sliding member comprises a box-shaped slider which opens at the bottom therefor and a skirt in hermetic sliding contact with the side portions of said body.

6. A dust suction apparatus according to claim **1**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

7. A dust suction apparatus according to claim **3**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said

openings between the side edges of said portion and the side portions of said body.

8. A dust suction apparatus according to claim **4**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

9. A dust suction apparatus according to claim **5**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

10. A dust suction apparatus according to claim **1**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes through which both the sides of said support member communicate with the bottom thereof.

11. A dust suction apparatus according to claim **3**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communicates holes through which both the sides of said support member communicate with the bottom thereof.

12. A dust suction apparatus according to claim **4**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes through which both the sides of said support member communicate with the bottom thereof.

13. A dust suction apparatus according to claim **5**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes through which both the sides of said support member communicate with the bottom thereof.

14. A linear movable table positioning unit including a dust suction apparatus for sucking dust generated at at least one of a linear movement guiding member and a ball screw member of said linearly movable table positioning unit comprising:

a channel body communicating with an exhaust section and having an open top extending in a longitudinal direction of said channel body, said channel body being arranged in parallel with at least one of a linear guide rail of said linear movement guiding member and a screw shaft of said ball screw member;

a flexible sheet for hermetically closing said open top;

a sliding member movable on said body along the longitudinal direction of said body while said sliding member remains in hermetic sliding contact with said body; and

an opening forming means provided in said sliding member for continuously separating a portion of said sheet from said open top so that said sheet hermetically closes said open top except at said portion, and for forming openings which communicate with said at least one of one of said linear movement guiding member and said ball screw member through a communication passage.

15. A linear movable table positioning unit according to claim **14**, in which said flexible sheet is made of metal.

16. A linear movable table positioning unit according to claim **15**, said dust suction apparatus further comprising:

a band-shaped magnet member provided at both the side portions of said body at said open top thereof for magnetically attracting said metal flexible sheet.

17. A linear movable table positioning unit according to claim **14**, in which said sliding member comprises a box-shaped slider which has an open portion at the bottom thereof and a skirt formed around said open portion and in hermetic sliding contact with the side portions of said body.

18. A linear movable table positioning unit according to claim **16**, in which said sliding member comprises a box-shaped slider which has an open portion at the bottom thereof and a skirt formed around said open portion and in hermetic sliding contact with the side portions of said body.

19. A linear movable table positioning unit according to claim **14**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

20. A linear movable table positioning unit according to claim **16**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

21. A linear movable table positioning unit according to claim **17**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

22. A linear movable table positioning unit according to claim **18**, in which said opening forming means comprises an arch-shaped plate which is mounted in said sliding member to lift the sheet at said portion thereof so as to make said openings between the side edges of said portion and the side portions of said body.

23. A linear movable table positioning unit according to claim **14**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes formed therein through which both the sides of said support member communicate with the bottom thereof.

24. A linear movable table positioning unit according to claim **16**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes formed therein through which both the sides of said support member communicate with the bottom thereof.

25. A linear movable table positioning unit according to claim **17**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes formed therein through which both the sides of said support member communicate with the bottom thereof.

26. A linear movable table positioning unit according to claim **18**, in which said opening forming means comprises a support member which has a crescent-shaped longitudinal section and communication holes formed therein through which both the sides of said support member communicate with the bottom thereof.

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